

The wise skeptic does not teach doubt but how to look for the permanent in the mutable and fleeting.

Ralph Waldo Emerson (1803–1882)

INVASIVE SPECIES

Do Noxious Neighbors Spread Disease?

Invasive plants are known for disrupting the ecologic balance in plant and animal communities.¹ They also may play a role in the spread of human diseases, according to a study of ehrlichiosis and its relationship to the noxious weed Amur honeysuckle (*Lonicera mackii*).²

Ehrlichiosis is an emerging disease that occurs in people and other animals. In people, one of the most prevalent culprits is the bacterium *Ehrlichia chaffeensis*, which causes a form of the disease known as human monocytic ehrlichiosis (HME).³ There also have been a few documented cases of HME caused by *Ehrlichia ewingii*. Both bacteria are transmitted by the lone star tick (*Amblyomma americanum*), a vector thought to feed primarily on the white-tailed deer (*Odocoileus virginianus*).⁴

HME was first reported in 1987, and the number of reported cases has risen steadily from about 100 in 1999 to 957 in 2008.^{5,6} The

10-fold increase likely is due to a combination of increased incidence, better reporting, and possibly increased exposure to lone star tick habitat through outdoor work and recreation, says Erik Hofmeister, veterinary medical officer with the U.S. Geological Survey (USGS) National Wildlife Health Center.

Amur honeysuckle, first introduced into the United States and Canada from eastern Asia in the 1800s,⁷ was widely used for landscaping, soil erosion control, and wildlife habitat enhancement, but its tendency to invade native settings was noticed as early as the 1920s.⁸ It seldom is used any more, says Robert Schutzki, an associate professor of horticulture at Michigan State University. Nonetheless, it's well established, often in urban and urban fringe areas, throughout much of the eastern half of the United States and Ontario, Canada.⁹

Noticing the overlapping geographic distribution of HME, lone star ticks, their hosts, and Amur honeysuckle, Brian Allan, now an assistant professor of entomology at the University of Illinois at Urbana-Champaign, set out to assess the relationship among these four factors. With his colleagues

he assessed nine natural areas in the St. Louis, Missouri, region, pairing honeysuckle-invaded and uninvaded plots measuring at least 30 m². They also compared invaded plots against those where they removed honeysuckle (either whole plants or just the fruit).

In both situations, they found a strong link between *Ehrlichia*-infected lone star ticks, deer, and Amur honeysuckle. Elaborating on figures published in his paper, Allan says the density of *E. chaffeensis*-infected tick nymphs¹⁰ in the honeysuckle stands was 25 times higher than in nearby stands of native vegetation, and deer density was 4 times higher. In areas where honeysuckle was removed, he says the density of *E. ewingii*-infected tick nymphs was

17 times lower than in nearby stands of honeysuckle vegetation, and deer density was 5 times lower.

One other invasive plant (Japanese barberry, *Berberis thunbergii*), has been linked with an emerging human illness (Lyme disease).^{11,12} Preliminary evidence indicates another invasive plant, garlic mustard, also may play a role in Lyme disease, says Felicia Keesing, an associate professor of biology at Bard College. Allan says the budding evidence suggests additional research on links between invasive plants and human diseases is needed.

Hofmeister is impressed with this study, including the in-depth analysis of the ecology of the disease, and he thinks it can have immediate applications. For instance, he says, "Homeowners could potentially reduce their risk of ehrlichiosis if they cleared the honeysuckle from around their property."

But Tom Stohlgren, a research ecologist at the USGS's Fort Collins Science Center in Colorado, is skeptical of the study's importance, though not entirely negative. "I think this is a tangential direction," he says. "It's better to go after the disease source itself, such as long-term increases in deer populations due to predator control, and increased urbanization into deer habitat. This study carries the argument deeper than it may need to go. But it's an interesting and important link, and I don't want to lose it."

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- Among the possible symptoms of HME are fever, headache, confusion, nausea, vomiting, diarrhea, and joint pain, though some infected people are symptom-free. Clinical signs last about three weeks, and complications such as renal failure or coma occur in 16% of patients. Another form of ehrlichiosis, called human granulocytic ehrlichiosis (HGE), is caused by *Anaplasma phagocytophila* and is transmitted by the blacklegged or deer tick (*Ixodes scapularis*). There were 1,009 cases of HGE in 2008, according to the Centers for Disease Control and Prevention.
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Vectors, hosts, invasive species, and people all living in close proximity may be a recipe for disease.



LIGHT POLLUTION

Light at Night and Breast Cancer Risk Worldwide

Several studies over the last decade have suggested that the modern practice of keeping our bodies exposed to artificial light at night, or LAN, increases cancer risk, especially for cancers (such as breast and prostate cancers) that require hormones to grow. Women who work night shifts have shown higher rates of breast cancer,¹ whereas blind women, who are not likely to be exposed to or perceive LAN, have shown decreased risks.² In 2007, the International Agency for Cancer Research declared shift-work a probable human carcinogen.³ Now a large study of 164 countries adds another piece of evidence, implicating overall light pollution.

The study, conducted by University of Connecticut epidemiologist Richard Stevens and colleagues at the University of Haifa, showed that higher population-weighted country-level LAN levels were associated with higher incidence of breast cancer.⁴ A sensitivity test indicated a 30–50% increased risk of breast cancer in countries with the highest versus lowest LAN levels. No such association was found between LAN and incidence of non-hormone-dependent lung, colorectal, larynx, or liver cancers in women.

“We took the top-level view and said, ‘If there really is causation going on, LAN levels worldwide should correlate well with breast cancer incidence,’” Stevens says. “This is a necessary but not sufficient condition for a potentially large effect. If we had seen no relationship between country LAN level and breast cancer risk, that would have been good evidence against a large effect of LAN on breast cancer risk.”

Tulane University cancer biologist David Blask points out the implications go beyond shiftwork. “This study suggests that all of us who live in industrialized society have the potential to have our circadian system disrupted by too much light at night, and this risk is potentially not restricted to a smaller percentage of the population that is exposed because of their occupation,” Blask says.

Harvard epidemiologist Eva Schernhammer agrees that the positive result from this study adds more evidence to the idea that LAN exposure contributes to breast cancer risk. But as an ecological study,⁵ even if the result had been negative, it would not be strong enough to rule out evidence from prior case–control studies, she says.

The study authors point out that because of the ecological nature of the study, it did not control for behavior that would reduce individuals’ exposure to LAN, such as sleeping. If people are actually asleep, then little to no light would reach their retinas, Stevens says, adding, “Three of four good prospective studies have reported a lower risk of breast cancer in women who report a long sleep duration.”⁶ Stevens thinks of reported sleep duration as a surrogate for time spent in the dark. But people do wake in the middle of the night, he points out, and even brief periods of open eyes during the night could expose the retina to LAN.

The new study highlights the need to understand the mechanisms behind the association between cancer and LAN, which aren’t clear, Stevens says. Previously, Blask and colleagues famously showed that a key factor in the connection is melatonin, a hormone produced in nighttime darkness that promotes sleep.⁷ They showed that growth and metabolism of human breast cancers growing in rats slowed when the tumors were perfused with melatonin-rich human blood collected during the night. In contrast, growth and metabolism were unchanged in tumors perfused with blood in which melatonin levels had been suppressed because of even a brief LAN exposure. Using the same model, Blask and George Brainard of Thomas Jefferson University have begun conducting pilot studies of the effects of melatonin and LAN on human prostate cancer.

Other studies are implicating over- or underexpression of genes known to be involved in the body’s circadian clock. For instance, Stevens and colleagues at Yale including Yong Zhu found that healthy control women showed lower expression of the *CLOCK* gene than women with breast cancer.⁸ They also found that epigenetic changes—the switching on or off of genes as a result of environmental factors—may play a role. For instance, an epigenetic change called promoter methylation, which turns off expression of *CLOCK*, was associated with lower risk of breast cancer.⁸ Stevens and Zhu are now studying whether women who work night shifts exhibit lower *CLOCK* promoter methylation.

Embrace the dark... for better health

Ways to reduce circadian disruption resulting from LAN exposure^{9–11}

- » Consider extending the dark period at night to 9 or 10 hours. Install room-darkening shades in bedrooms.
- » Avoid even brief light exposures. Turn off the lights, television, and computer in the bedroom when you are sleeping. Avoid watching television or working on the computer right before you shut your eyes.
- » If you get up in the night, forgo the usual bathroom lights for a dim red nightlight. Red light suppresses melatonin production less than other wavelengths.
- » Do not take melatonin tablets unless directed by a physician. The spike in circulating melatonin may actually worsen, not alleviate, circadian disruption.

Another big question is how much of a contribution LAN makes to cancer risk. “Light at night is likely to be one of a number of factors that contributed to the increase in breast cancer over the last few decades,” says Les Reinlib, the program director who coordinates NIEHS grants related to health effects of LAN. “It seems to be significant, and if it is, then that’s something we can control.”

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NANOMATERIALS

Transformation of Silver Nanoparticles in Sewage Sludge

The release and environmental fate of nanoparticles throughout the life cycle of “nanoenabled” goods is an area of growing research interest. In the first known field study of the fate of silver nanoparticles in the wastewater treatment system, researchers now report these nanoparticles transform into silver sulfide in the sludge produced by sewage treatment plants.¹ This new information about the life cycle of silver nanoparticles provides a starting point for further exploring their impact on the environment.

Silver has been used as an antimicrobial agent for millennia,² and the increased surface area offered by the nanoparticle form of the metal offers greater germ-killing capacity.³ Today, manufacturers add silver nanoparticles to hundreds of consumer products, including food storage containers, clothing, computer keyboards, cosmetics, pillows, cell phones, and medical appliances.⁴

Silver is water soluble, so contact with any type of moisture—such as a bath or a spin in the washing machine—washes some out and sends it into wastewater systems. “We wanted to know what form of silver enters the environment after it goes down the drain and passes through sewage treatment plants,” says Michael Hochella, a geochemist at Virginia Polytechnic Institute and State University and director of natural and incidental nanoparticles for the multi-institute Center for the Environmental Implications of NanoTechnology.⁵

Sludge from sewage treatment facilities can end up as landfill or soil amendments in agricultural fertilizers, or it can be burned in incinerators. In 2006 and 2007 the U.S. Environmental Protection Agency

(EPA) analyzed sewage sludge samples from 74 municipal wastewater treatment facilities nationwide and tested for 28 metals, including silver (which was detected in all the samples).⁶ Through the EPA, Hochella and postdoctoral fellow Bojeong Kim obtained frozen samples of sludge from a Midwest facility. They suspected it would contain the nanosilver particles now used in consumer products—although the EPA’s goal in sampling was simply to obtain national estimates of the concentrations of selected analytes, not identify nanoparticles.

Kim developed analytical methods to determine the size, chemistry, and atomic structure of silver nanoparticles in the samples. The samples tested high in silver, but the silver could not be attributed to an industrial source. Scanning transmission electron microscopy revealed the nanoparticles were 5–20 nm in diameter and formed small, loosely packed aggregates no more than 100 nm in size. Energy-dispersive X-ray spectrometry showed that sulfur (which is produced by microorganisms that digest sewage) combined with the silver in a 2:1 ratio, and the crystal structure confirmed the formation of silver sulfide nanoparticles.¹

The results underscore the complexity of environmental fate. “What we start with is not what ends up in the environment,” Hochella says. The researchers don’t know how many silver nanoparticles were introduced to the wastewater treatment plants or how much incoming nanosilver ended up as silver sulfide nanoparticles. However, Kim notes that no pure silver nanoparticles were found in the sludge.

In general, silver sulfide is highly insoluble and settles out of water.⁷ But no one knows if silver sulfide nanoparticles behave in the same way. Properties of metals can change dramatically as particle size decreases.³ “It’s hard to predict whether the solubility of nanoparticles will increase, decrease, or stay the same,” Kim says. The bioavailability, toxicity, and reactivity of silver sulfide nanoparticles also are unknown.

The Beat

by Erin E. Dooley

Clearer Picture of Ground-Level Ozone Formation

Knowing how hydroxyl radicals combine with nitrogen dioxide from fossil fuel burning is important for better predicting the formation of air pollutants such as ground-level ozone and nitric acid. Now scientists have filled in some important knowledge gaps about this chemical

reaction: the overall speed at which hydroxyl radicals and nitrogen dioxide react in given atmospheric conditions and the ratio of stable nitric acid to unstable nitric acid that is formed under such conditions.¹ Their findings suggest most current computer models may underestimate ozone levels by 5–10% in highly polluted areas.

Nature Rx

Over the next two years, the National Environmental Education Foundation’s Children and Nature Initiative expects to provide more than 1,200 health care providers with science-based knowledge, technical support, patient resources, and other tools they can use to prescribe outdoor time for children and their families.² The goal of the program is to avail children of the physical and mental health benefits associated with unstructured outdoor play.³ Working with a number of federal and nonprofit partners, the program also will educate health care providers about

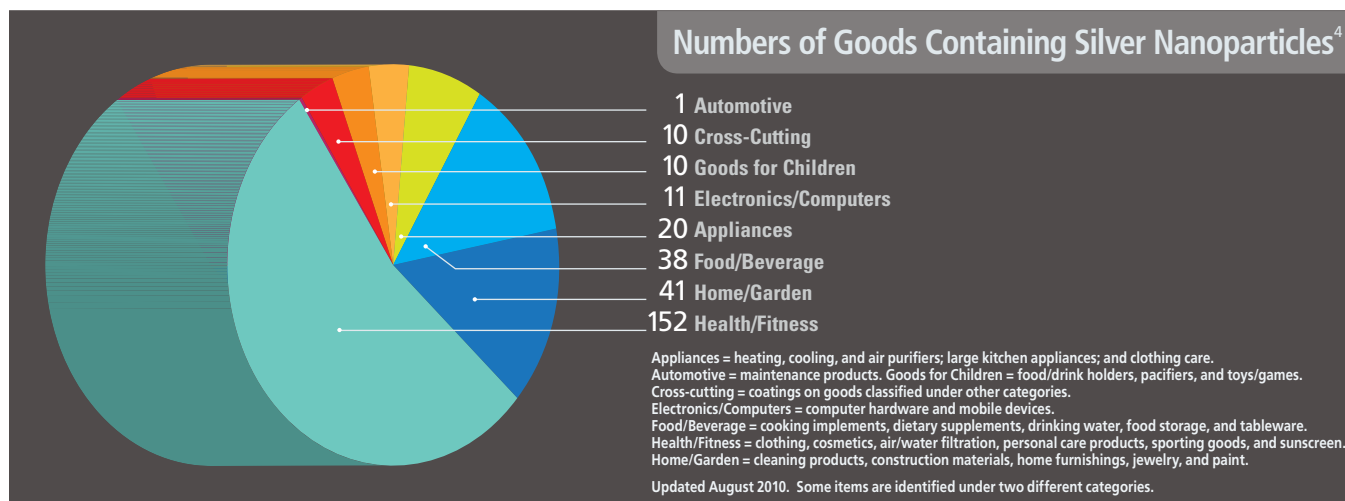


safe, accessible local outdoor sites they can recommend to their patients.

Metrics for Partnerships

The NIEHS Division of Extramural Research and Training has issued the first draft of the Partnerships for Environmental Public Health (PEPH) Evaluation Metrics Manual for measuring partnership-building activities.⁴





If silver sulfide nanoparticles do prove toxic, the environmental implications could be unfavorable. Antimicrobial nanoparticles could adversely impact desirable microorganisms that decompose waste in sewage treatment plants, says Murray McBride, director of the Cornell Waste Management Institute. Furthermore, McBride says, nanosized silver sulfide applied to agricultural land could oxidize in soils and release toxic silver ions that kill beneficial soil microorganisms. On the other hand, one study of laboratory-grown *Pseudomonas putida* biofilms indicated some bacteria bind silver ions, potentially rendering them less toxic.⁸

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The manual provides metrics that can be used to assess activities' effectiveness and impact, evaluate program successes and challenges, justify further funding, and identify new audiences and applications for projects. Although designed for the NIEHS's PEPH grantees, the manual applies to anyone working to build partnerships to address public health issues. The NIEHS invites the public to review the manual and provide feedback.⁴

Health Care Policy through the Lens of Environmental Health

In September 2010 the Research Triangle Environmental Health Collaborative held a summit titled America's Health Care Policy through the Lens of Environmental Health.⁵ Discussions in the realms of policies; research and analytical tools; and outreach, education, and mobilization all concluded that safeguarding public health requires a focus not just on health care reform but on reforming the public's ideas about health itself. Collaborative leaders are preparing

recommendations to present to Congress sometime in 2011.

Report Highlights Arctic Issues

Several projections estimate the Arctic Ocean will be ice-free in the late summer months by the late 2030s—a dramatic ecologic change for this region. A new report prepared for Congress surveys potential issues that might



arise as a consequence of diminishment of Arctic ice.⁶ The report outlines predictions of probable increases in shipping, fishing, tourism, and petroleum extraction activities in the region, potentially leading to increased pollution, stresses on wildlife and marine stocks, and impacts on traditional livelihoods. It also touches on concerns about potential health problems related to climate change that may particularly affect Arctic indigenous peoples.

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